DIAGNOSTIC TELEMETRY SYSTEM

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Abstract

The theoretical aspects of diagnostics and diagnostic methodology are an important issue. Apart from theoretical aspects, this paper presents experiment results and a practical implementation example. Telemetry has a numbe of different definitions, depending on the area of application. It is generally defined as data acquisition at a remote, inconvenient and/or dangerous location and subsequent transmission of the data to another location for analysis. Telemetry systems are increasingly popular. The most widely used systems include the equipment for monitoring truck scales. The data obtained with this method allow estimating vehicle weight with accuracy between 90% and 98%. Currently a large number of ready-made, professional telemetry systems are commercially available. The LabView programming language used in this example allows for data visualization and acquisition. It also allows saving the executed program as an individual application. The measurements additionally included temperature, throttle position and battery voltage. Experiments proved that for stable communication an 80 kbps band is required. The commonly used telemetry systems, and even their custom-made original versions (as the one here presented), allow for remote diagnostics of an object using widely available communication technologies. The problem seems to be very development and requires further studies, which are scheduled in the near future.

Keywords: telemetry, IPv6, EOBD

1. Introduction

The theoretical aspects of diagnostics and diagnostic methodology are an important issue. Apart from theoretical aspects, this paper presents experiment results and a practical implementation example. The signal-conditioning methodologies here described may be utilized on board of the vehicle, which currently remains a rare solution. However, as domain computation, the so-called *Cloud Computing*, gains in popularity, some significance attaches to the fact that such system may be implemented on a remote computer located at a distance from the vehicle. This problem seems to be one of the reasons behind IETF (*Internet Engineering Task Force*) to begin work on a new communication protocol referred to as IPv6.

Telemetry has a number of different definitions, depending on the area of application. It is generally defined as data acquisition at a remote, inconvenient and/or dangerous location and subsequent transmission of the data to another location for analysis. The most popular areas where telemetry is employed include the movement of vehicles, aircraft and rockets [1].

2. Telemetry systems

Because of its application requirements, a telemetry system comprises (Fig. 1):

1. Data collection subsystem. As far as the research here presented is concerned, this element is intended to collect data on vibration using accelerometers or laser vibration meters, to condition the received analogue signal and to send it in discrete form to a further part of the system.
2. A subsystem that prepares data for transmission. Because air is the most common, and in fact, the only practically used medium that allows for the transmission of electromagnetic waves, modulation (here: multiplexing) is necessary. Three basic types of multiplexation are distinguished [3, 5]:
   2.1. Frequency division – in this case data are divided into separate frequency ranges to enable their further transmission.
   2.2. Time division – data are transmitted in packages (in IT frequently referred to as segments, datagrams or packets), with the size of the package being adjusted to the so-called window.
   2.3. Hybrid types that employ both of the above multiplexation systems.
3. Modulator, transmitter and antenna. The role of the system is in this case obvious; signal amplification is frequently needed.
4. Transmission medium.
5. Receiver system – antenna and amplifier.
6. Demultiplex system – this is where the carrier wave is removed, data is decapsulated and individual packets are reassembled.
7. Data analysis system. The here presented methodology for acoustic vibration analysis will require a computing unit with software that allows to perform conditioning of the received signal (windowing, filtrating, FFT, decomposing etc.)
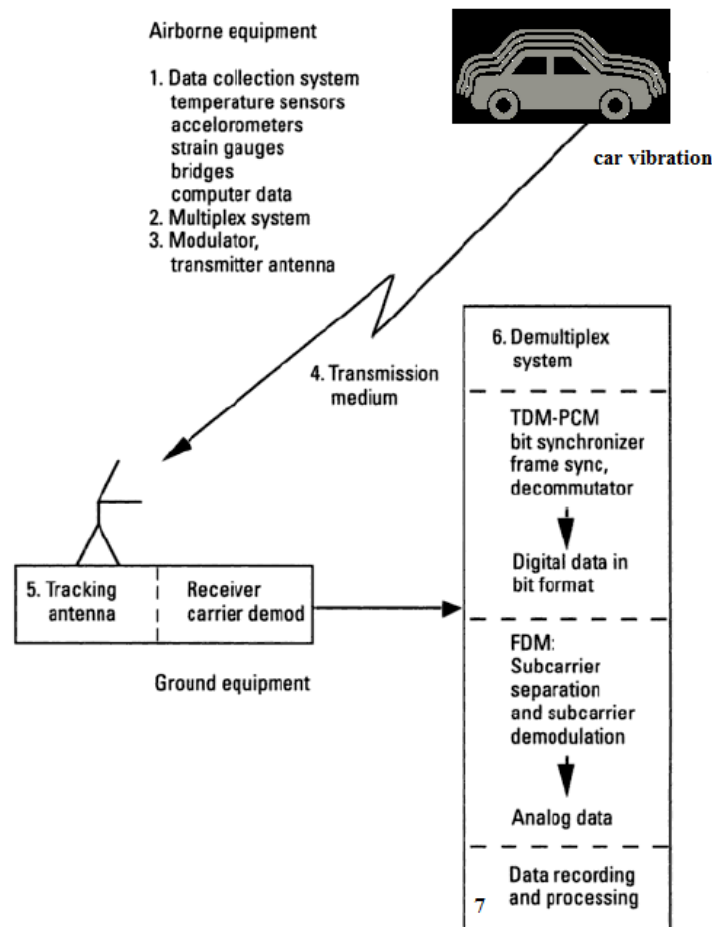

Fig. 1. Telemetry system for the acquisition of vibrocoustic signals from a vehicle

3. Implementation example

Telemetry systems are increasingly popular. The most widely used systems include the equipment for monitoring truck scales. As is widely known, vehicle overloading causes road damage. Until recently, the cost of telemetry system was higher than the cost or road repairs. In addition, telemetry is a relatively new technology and hence a limited number of engineers and specialists in the field can be found in the job market. Except for installing "classic" scales (Fig. 2), which require maintenance and operate properly only when the vehicle comes to a standstill, special systems are used which collect such data as power, loads on the suspension elements, rotational speed of the crankshaft, torque and vehicle speed to calculate vehicle load. The data obtained with this method allow estimating vehicle weight with accuracy between 90% and 98% [1, 4]. The main advantage of this system is the ease of implementation (using special-purpose, but batch-produced devices). Currently a large number of ready-made, professional telemetry systems are commercially available. These include among others: FM40 Telemetry System, Telematics AVS i-Tdiaq, SPAA05 Race Car Telemetry System.

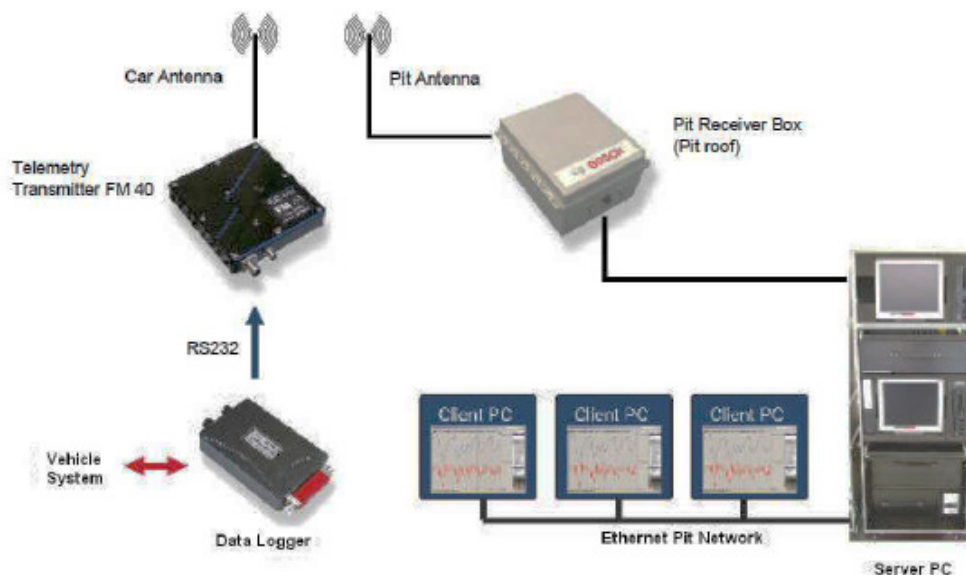*Fig. 2. Classical weight measurement*

Fig. 3. Bosch FM40 telemetry system [2]

Remote data transmission seems a perfect solution. Apart from the comparative analysis of vibracoustic signals produced by different states of the engine, telemetry may be also used to monitor a group of vehicles of the same type.

In addition to using traditional telemetry to send a number of parameters collected from vehicle data bus, another natural and easy solution is to connect the vehicle to accelerometers and to send the data through an encrypted VPN (*Virtual Private Network*) channel. The remote data acquisition system (based on GSM network), which is presented below, incorporates commonly available devices such as a 3G modem with built-in router function, two computers and data acquisition card from NI. The system's design is based on LabView object programming language. Fig. 4 shows its schematic diagram.
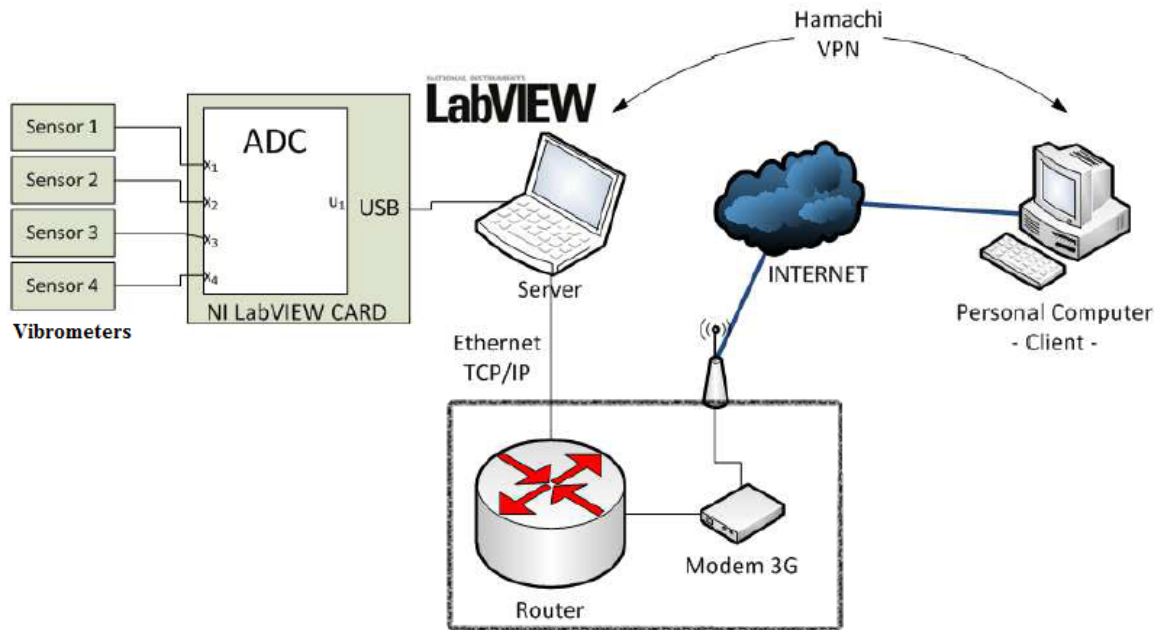

Fig. 4. Schematic diagram of the data acquisition system

The here presented system is a special-purpose extension to a classic telemetry system shown above. The measurement is started on board of the vehicle, using data acquisition card with four inputs. The discrete signal thus obtained (measurement parameters are of importance here, and are selected individually, depending on the type of vibration measured; however, this process may also be automatized) is transmitted to the computer (in this case via USB port), and the computer sends the signal to the GSM router (an integrated switch, router and 3G radio modem). In the next step, the signal is sent further through an individualized and encrypted VPN channel (in this case a cost-free solution from Hamachi VPN was chosen) to a stationary computer located at the computational centre. The resulting diagnostic signal may be analysed and subjected to the process of acquisition.

The LabView programming language used in this example allows for data visualization and acquisition. It also allows saving the executed program as an individual application. Fig. 5 shows an application allowing for data acquisition through the telemetry network presented in Fig. 4.

The graph displayed in the bottom right corner of Fig. 5 shows the vibration as measured by the application. The measurements additionally included temperature, throttle position and battery voltage. Experiments proved that for stable communication an 80 kbps band is required.

The commonly used telemetry systems, and even their custom-made original versions (as the one here presented), allow for remote diagnostics of an object using widely available communication technologies.
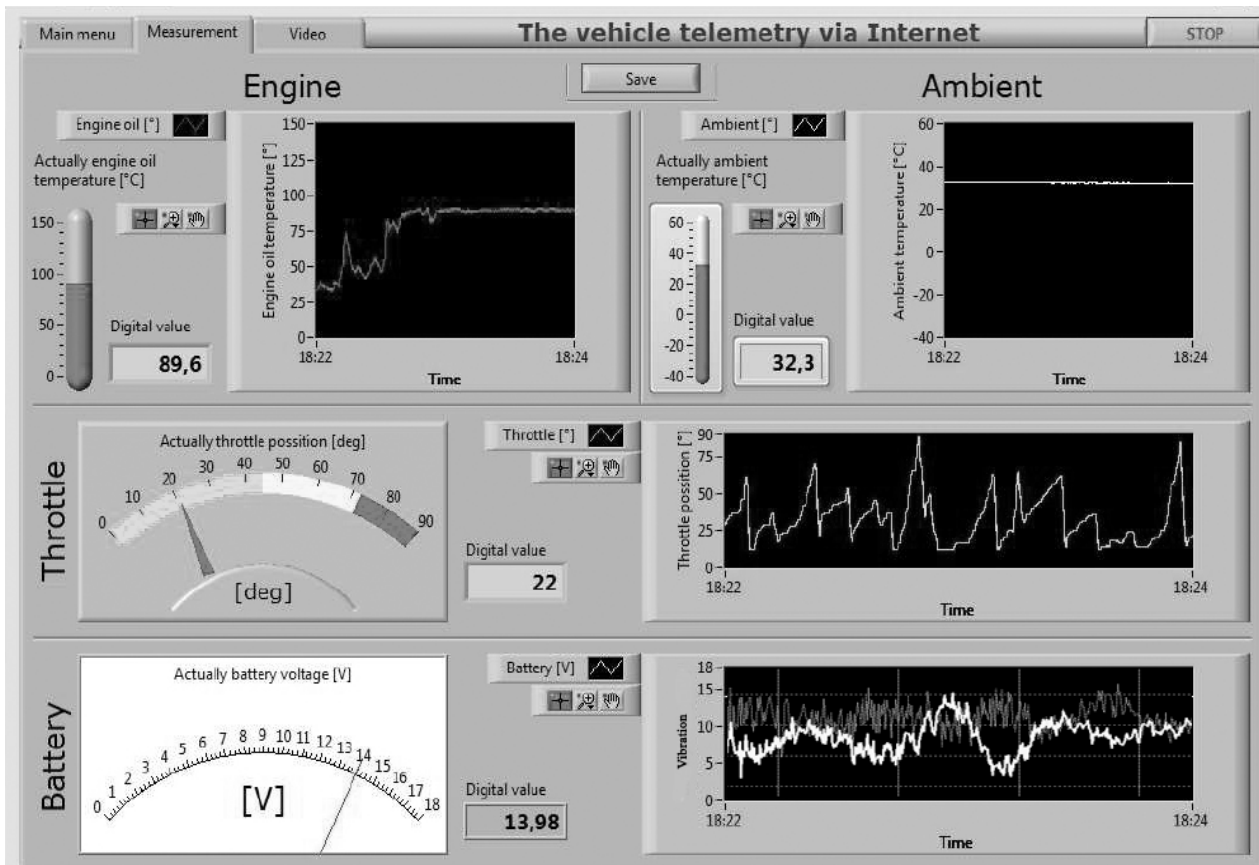
Fig. 5. Special-purpose console for the telemetry data transmitted via 3G VPN.

4. Conclusions

1. The effectiveness of systems using the acquisition of data is equal to 98%.
2. Systems using data acquisition to measure the weight of the vehicle lead to a reduction in inspection procedures.
3. Telemetry systems allow for remote diagnostics of an object using widely available communication technologies.
4. The current telemetry systems are the base for remote control vehicles. This is particularly visible in the light of the new IPv6 protocol. Since you are until it contains 128 bits, allowing addressing of the host, this means that $2 \char94 128$ nodes may have a unique address. In the future, telemetric data will be used as part of a feedback loop in the global system telemetry. This system will consolidate (also traffic) telematics and telemetrics systems in vehicles so that it became possible to remote control of them. The vehicle traffic will then be slower and safer, but passengers will be faster at the end, thanks to its flowability and scalability.

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